FELLOW EYES OF GIANT RETINAL BREAKS*

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INTRODUCTION

GIANT RETINAL BREAKS MAY BE DEFINED AS RETINAL BREAKS that extend 90 degrees or more around the circumference of the retina.[1] They occur in approximately one in 2,000,000 people per year in the general population and in about one in 200 rhegmatogenous retinal detachments.[2-4] With advances in surgical techniques,[5-15] results in the management of giant retinal breaks are improving; however, a considerable number of eyes continue to be lost. In addition, there is a high incidence of retinal breaks and retinal detachment in the fellow eye. For these reasons the management of the fellow eye of giant retinal breaks is important. This report deals with a study of the fellow eyes of 226 nontraumatic giant retinal breaks that I have examined during the past 16 years. It reports the results of prophylactic treatment and makes recommendations regarding the management of fellow eyes.

MATERIAL

The charts of 303 patients with a giant retinal break examined between 1961 and 1977 were reviewed. Thirty giant retinal breaks that developed following ocular trauma were excluded from the study. Also excluded were 47 patients with a normal fellow eye and a giant retinal break suspected to be the result of nonpenetrating ocular trauma as indicated by angle recession, iridodialysis, cyclodialysis, ruptured iris sphincter, dislocated lens, vitreous hemor-

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rhage, a history of hyphema, or lid laceration. After the above exclusions, a series of 226 consecutive nontraumatic giant retinal breaks were analyzed.

The fundi of 20 of the 226 eyes could not be examined because of phthisis, an opaque cornea, or enucleation. However, information was obtained that the retinal breaks or retinal detachment had been present in six of these 20 eyes.

METHOD

INITIAL EXAMINATION

At the initial examination, ocular history was taken with an emphasis on family history of retinal detachment, ocular injury, and visual symptoms in the fellow eye. Inquiry was made regarding prematurity, cleft palate, and facial or joint abnormalities. Ocular examination included measurement of the visual acuity, tonometry, gonioscopy, anterior and posterior segment biomicroscopy, and binocular indirect ophthalmoscopy with scleral depression.

Visual acuity was recorded with best correction or pinhole. An estimate of the refractive error was made on the basis of the last correction worn by the patient. An eye was listed as myopic when a concave sphere had been prescribed for distance vision. In the case of astigmatism, an eye was considered myopic when the spherical equivalent of its correction was on the minus side. This method of recording myopia has its limitations; however, it was used because it is often impossible to perform retinoscopy on an eye with a retinal detachment. As a result, some low myopes have escaped notice and patients with high myopia, unilateral myopia, and myopic anisometropia who were probably undercorrected, had their degree of myopia underestimated.

Intraocular pressure was measured with the Schiøtz tonometer prior to 1974 and with the applanation pneumotonometer after that year. Gonioscopy was performed using the Koeppe lens and handheld biomicroscope. The vitreous was examined with the Goldmann three-mirror contact lens and slit lamp biomicroscope. Biomicroscopic findings of the vitreous cavity were recorded on a standard form which shows cross sections oriented through significant findings. A large fundus drawing was made recording chorioretinal degenerations, retinal breaks, and white with or without pressure.

TABLE I. AGE AND SEX IN PATIENTS WITH GIANT RETINAL BREAKS (226 PATIENTS)

Age (Years)	No. (%) Male	No. (%) Female
0-10	23 (10.2)	5 (2.2)
11 - 20	36 (15.9)	13 (5.8)
21 - 30	21 (9.3)	8 (3.5)
31 - 40	16 (7.1)	4 (1.8)
41 - 50	44 (19.5)	5 (2.2)
51 - 60	34 (15.0)	3 (1.3)
61 - 70	12 (5.3)	2 (0.9)
TOTAL	186 (82.3)	40 (17.7)

FOLLOW-UP EXAMINATIONS

All patients were warned of the possibility of the occurrence of retinal breaks in the fellow eye and were told to report symptoms of flashes, floaters, or diminution in vision. They were instructed to check the vision of the fellow eye at regular intervals. Follow-up examinations were scheduled at intervals of one, two, four, and six months following treatment of either eye. These examinations included a measurement of visual acuity, tonometry, biomicroscopy, and indirect ophthalmoscopy with scleral depression. Prior to 1972, ophthalmoscopic findings in the fellow eye were recorded on a small sketch of the fundus. After 1972, in an attempt to more accurately record fundus changes, new findings were drawn on a semitransparent acetate sheet placed over the original large fundus drawing. Beginning in 1972, biomicroscopic vitreous findings were similarly recorded on acetate overlays. Postcard questionnaires concerning the status of the fellow eye were sent to the referring ophthalmologist regarding patients who failed to return for follow-up.

FINDINGS

AGE AND SEX

The 226 patients ranged in age from three months to 67 years. The average age was 34 years. One hundred eighty-six (82.3%) of the patients were men and 40 (17.7%) were women (Table I). The average age was 35 years for the men and 25 years for the women. One hundred twenty-seven (56.2%) patients were under the age of 40 years.

DEVELOPMENTAL AND CONGENITAL ANOMALIES

Five (2.2%) patients had retrolental fibroplasia. A high incidence of

TABLE II. RETINAL BREAKS IN APHAKIC EYES FOLLOWING EXTRACTION OF A SENILE CATARACT (13 EYES)

	No. (%) Eyes
Giant Retinal Break	3 (23.1)
Retinal Tear	5 (38.4)
Retinal Detachment	4 (30.8)
Retinal Hole	1 (7.7)
TOTAL	13 (100)

ocular and systemic congenital abnormalities were noted, occurring in 66 (29.2%) patients. Congenital abnormalities involving the lens, connective tissue, bone, and hard palate were observed in 34 (15.0%) patients. Eight (3.5%) of the 226 patients had developmental giant retinal breaks associated with a nasal coloboma of the lens.[16] Eight (3.5%) patients were diagnosed as having Marfan's syndrome, three (1.3%) patients had congenital spondyloepiphyseal dysplasia, and ten (4.4%) patients had a cleft palate.

APHAKIA

Inasmuch as 56.2% of giant retinal breaks occur in patients under the age of 40 years, the incidence of aphakia was low. Only 32 (14.2%) of the 226 fellow eyes were aphakic. Congenital cataract surgery had been performed on 19 (59.4%) of 32 aphakic eyes and an intracapsular lens extraction was performed for senile cataract on 13 (40.6%) eyes.

Aphakia Following Congenital Cataract Surgery:

Bilateral congenital cataract surgery had been performed on all of the 19 patients that presented with a history of congenital cataracts. Four (21.1%) of 19 fellow eyes were phthisical, two (10.5%) of four eyes with a giant retinal break were inoperable, retinal breaks were present in two (10.5%), and the retina was detached in three (15.8%) eyes. During the follow-up, four (21.1%) eyes developed a retinal detachment; therefore, by the end of the observation period of this study retinal breaks or retinal detachment had developed in 17 (89.5%) of 19 fellow eyes that had undergone surgery for congenital cataract.

Aphakia Following Lens Extraction for Senile Cataract:

Thirteen (100%) of the fellow eyes in which a senile cataract had been removed contained retinal breaks or retinal detachment (Table II). The time lapse between cataract extraction and diagnosis of retinal breaks or retinal detachment was less than one year in six

TABLE III. REFRACTIVE ERROR OF FELLOW EYES OF GIANT RETINAL BREAKS (95 EYES)

	No. (%) Male	NO. (%) Female
Myopia	62 (65.3)	15 (15.8)
Hypermetropia	6 (6.3)	0 (0.0)
Emmetropia	10 (10.5)	2 (2.1)
TOTAL	78 (82.1)	17 (17.9)

(46.2%) of 13 eyes, ranging from three weeks to seven years, the average time lapse was 33 months. The time lapse between lens extraction and the diagnosis of a giant retinal break was three weeks for one patient and seven weeks in another patient. A 51-year-old highly myopic woman was found to have bilateral giant retinal breaks six weeks after uncomplicated lens extractions performed on both eyes on the same day. No information could be obtained regarding the preoperative appearance of the fundi. Unfortunately the retina could not be reattached in either eye. Cataract extraction in the fellow eye of a 51-year-old man was followed three weeks later by the development of a giant retinal break. Eight years earlier this patient developed a 355 degree giant retinal break in the presenting eye which was unsuccessfully operated upon. The fellow eye was examined at regular intervals during the eight years prior to the lens extraction. During that period, islands of white with pressure increased in length to coalesce into a band extending 360 degrees around the fundus periphery. During the early stages of cataract formation, extensive syneresis of the vitreous gel and condensation at the vitreous base were observed. Later, cataractous changes hampered biomicroscopy of the vitreous making it impossible to correlate vitreous changes with increasing fundus pathology. When vision had decreased to less than 20/200, the lens was extracted in an uncomplicated procedure. A 190 degree giant retinal break developed three weeks later. Four operations were performed before the retina was reattached.

TABLE IV. MYOPIA, AGE, SEX IN FELLOW EYES OF GIANT RETINAL BREAKS (77 EYES)

	Under 40 Years		Over 40 Years	
Degree of Myopia	No. (%) Male	No. (%) Female	No. (%) Male	No. (%) Female
0 to -8.00 diopters	23 (29.9)	5 (6.5)	15 (19.5)	3 (3.9)
Over -8.00 diopters	23 (29.9)	7 (9.1)	1 (1.3)	0 (0.0)

REFRACTIVE ERROR

The refractive error was recorded in 95 fellow eyes; 77 (81.1%) were myopic, 12 (12.6%) eyes were emmetropic, and six (6.3%) were hyperopic. Myopia was present in 62 (79.5%) of 78 men and 15 (88.2%) of 17 women (Table III). Myopia of -8.00 diopters or more was recorded in 31 (40.3%) of the 77 myopic patients (Table IV).

VITREORETINAL FINDINGS

The incidence, morphology, follow-up, and management of vitreoretinal changes which occurred in fellow eyes of giant retinal breaks will be discussed under: I. Giant Retinal Breaks; II. Retinal Detachment; III. Retinal Tears; IV. Retinal Holes; V. Retinal Dialysis; VI. Lattice-like Degeneration; VII. Chorioretinal Atrophy; and VIII. White With Pressure.

Giant Retinal Breaks:

a Incidence. At the initial examination a giant retinal break in the fellow eye was noted ophthalmoscopically or by history in 15 (6.6%) patients (Table V). During the follow-up period this 6.6% incidence of bilaterality increased to 12.8% as an additional 14 giant breaks developed in fellow eyes.

b Latent Period. Excluding the giant retinal breaks that developed three and seven weeks after lens extraction, the average interval between the diagnosis of the giant tear in one eye and the spontaneous development of a giant break in the fellow eye was 3½ years. The longest latent period was six years, seven (50%) of the 14 giant breaks developed within three years.

c Morphology. Eighteen (62.1%) of the giant retinal breaks that occurred in the fellow eyes of 29 patients by the end of the study were larger than 180 degrees. The posterior flap of the giant tear

TABLE V. FOLLOW-UP OF FELLOW EYES OF GIANT RETINAL BREAKS (226 EYES)

	Initial Examination No. (%) Eyes	By the End of Follow-up No. (%) Eyes
Giant Retinal Breaks	15 (6.6)	29 (12.8)
Retinal Tear Without Detachment	20 (8.8)	27 (11.9)
Retinal Hole Without Detachment	19 (8.4)	23 (10.2)
Retinal Dialysis Without Detachment	1 (0.4)	1 (0.4)
Retinal Detachment Not Caused by Giant Retinal Break	27 (11.9)	36 (15.9)
TOTAL	82 (36.1)	116 (51.3)

was inverted over the optic disc in 14 (48.3%) eyes, it was partially inverted in 10 (34.5%) eyes, and showed no tendancy for inversion in five (17.2%) eyes. Massive preretinal retraction was present in 12 eyes (41.4%).

d Follow-Up. Three patients with a giant break in one eye did not return for follow-up of the fellow eye until it had developed a giant retinal break. Ophthalmoscopic changes were observed in the fundi of ten (90.9%) of 11 fellow eyes that were followed regularly prior to the development of a giant retinal break. These ten eyes had marked white with pressure occurring in elongated patches anterior to the equator. The white with pressure remained unchanged in four eyes. Adjacent areas of white with pressure increased in size circumferentially to become confluent in six eyes. As the white with pressure spread, it became more dense and developed a sharp posterior edge in contrast to a hazy posterior border seen earlier. The giant retinal break usually developed along the sharp posterior edge of the white with pressure.

The progressive course of the white with pressure is illustrated in a -18.00 diopter myopic fellow eye of a 270 degree giant retinal break that could not be reattached. The patient was an 8-year-old girl with a cleft palate and saddle shaped nose. Retinal white with pressure was present in the region of the equator temporally from the 12:45 to the 2:15 o'clock meridian and from the 3:15 to the 5:45 o'clock meridian (Fig. 1A). Six months later another island of white with pressure had developed slightly posterior to the equator between the 2:00 and 3:15 o'clock meridian. The white with pressure inferior temporally extended anteriorly to the ora serrata and nasally to the 7:30 o'clock meridian. Condensation at the vitreous base was evident ophthalmoscopically as a veil-like membrane extending from the 11:00 to the 3:00 o'clock meridian parallel to the ora serrata in the region of the anterior vitreous base (Fig. 1B). By the end of the six months the retinal white with pressure extended nasally to the 9:00 o'clock meridian, increased in density, and the posterior margin had become sharp. The retinal white with pressure between the 2:00 and 3:30 o'clock meridian took on a yellow frosted appearance. Condensation of the nasal vitreous base was evident by a membrane in the region of the posterior border of the vitreous base between the 8:00 and 10:15 o'clock meridian (Fig. 1C). During the five months

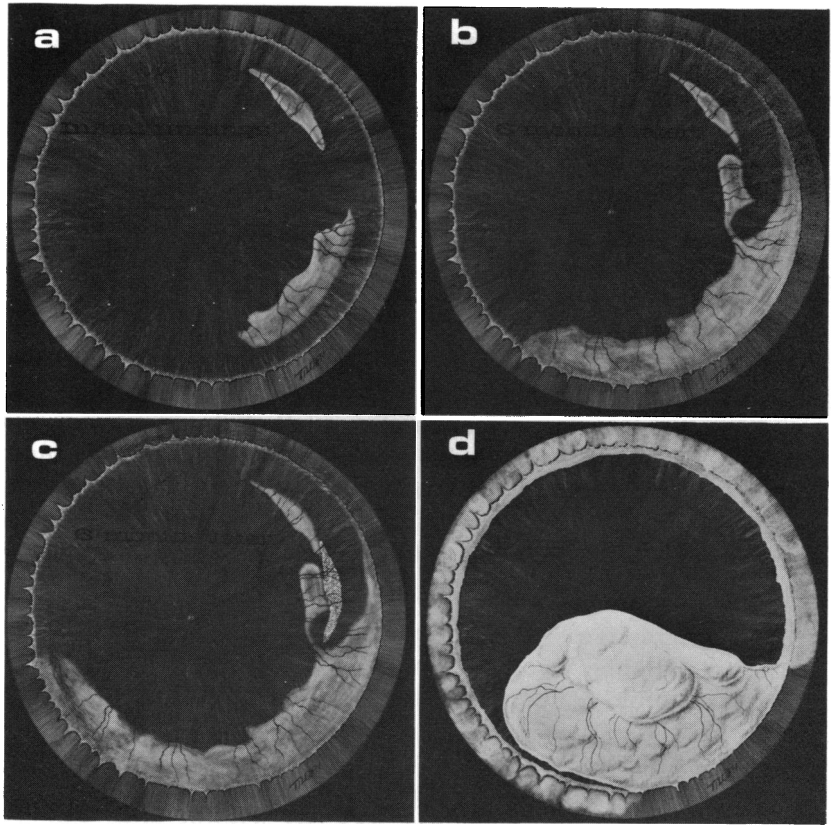

FIGURE 1

Progressive course of retinal white with pressure. A: Initial examination: Retinal white with pressure is present in the equatorial region from 12:45 to 2:15 o'clock and from the 3:15 to the 5:45 o'clock meridian. B: Six months later an island of retinal white with pressure has developed posterior to the equator between the 2 and 3:15 o'clock meridian and confluent with white with pressure extending to the 7 o'clock meridian. Condensation at the vitreous base is seen as a membrane extending from the 11 to the 3 o'clock meridian anterior to the ora serrata. C: Six months later, retinal white with pressure extends to the 9 o'clock meridian and has increased in density. A membrane in the region of the posterior vitreous base extends from the 8 to the 10:15 o'clock meridian. Retinal white with pressure between the 2 and 3:30 o'clock meridian has a frosted yellow appearance. D: Five months later, a 270 degree giant break with an inverted retinal flap extends from the 6 to the 3 o-clock meridian. The ora serrata, pars plana ciliaris, and anterior edge of the giant tear are detached.

following that examination, the patient noted flashes during the formation of a 280 degree giant retinal break that was operated three times unsuccessfully (Fig. 1D).

Syneresis, liquefaction, and condensation of the vitreous base were noted in ten (90.9%) of 11 fellow eyes that developed a giant retinal break during the follow-up. The syneresis and liquefaction involved most of the gel except the anterior portion including the vitreous base. In four eyes, vitreous base condensation could be seen ophthalmoscopically as a faint, cellophane-like veil running parallel and slightly anterior or posterior to the ora serrata (Fig. 1B). The fellow eye in which no chorioretinal changes were observed prior to the onset of a giant retinal break showed progressive syneresis and vitreous base condensation.

e *Management.* The giant retinal breaks were treated with scleral buckling, vitreous injection, and in recent cases a closed vitrectomy.

Retinal Detachment Caused by Retinal Breaks other than Giant Retinal Breaks

a *Incidence.* Retinal detachment was present in the fellow eye at the initial examination of the giant retinal break in 27 patients (11.9%) (Table 5). Nine (3.9%) additional retinal detachments developed during the period of this study, therefore retinal detachment caused by retinal breaks other than giant retinal breaks were observed in 36 (15.9%) fellow eyes.

b *Morphology.* The location of the retinal break could not be determined in 21 eyes because of chorioretinal scarring from previous retinal detachment surgery, opaque media, or enucleation. In 15 eyes the retinal breaks were visible or their location was estimated from the posterior extent of an existing scleral buckle. Retinal breaks in these 15 eyes were located in the region of the ora serrata in 11 (73.3%) eyes and in the region of the equator in four (26.7%) eyes. The type of retinal break could not be determined in 25 (69.4%) of the 36 eyes with retinal detachment, retinal tears were present in seven eyes, retinal holes in two eyes, and a retinal dialysis in one eye. At the time of diagnosis of the retinal detachment, the macula was attached in 23 (63.9%) eyes.

c *Follow-Up.* Nine (3.9%) additional rhegmatogenous retinal detachments developed during the follow-up of the 226 fellow eyes of giant retinal breaks. The interval between the diagnosis of the giant retinal break and the retinal detachment in the fellow eye varied from ten months to four years, the average being 27 months. These retinal detachments were caused by retinal tears

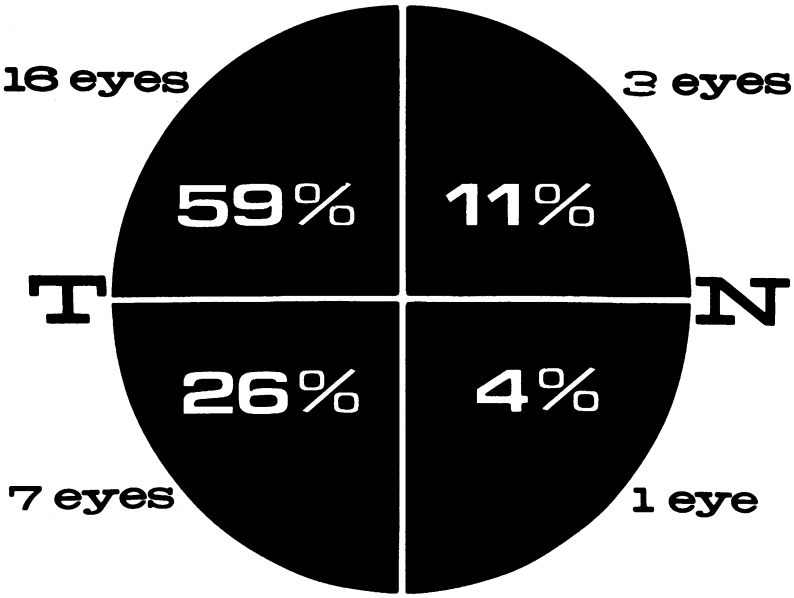

FIGURE 2
Location of retinal tears in fellow eyes of giant retinal breaks.

in four (44.4%) eyes, retinal dialysis in three (33.3%) eyes, and by retinal holes in lattice-like degeneration in two (22.2%) eyes. Three of the nine eyes in which retinal detachment developed contained lattice-like degeneration. The retinal breaks were located in the superior temporal quadrant in six (66.7%) eyes, superior nasally in two (22.2%) eyes, and inferior nasally in one (11.1%) eye. Early diagnosis was made in all cases before the macula was detached. In eight of the nine eyes the retinal detachment involved less than one quadrant. Increasing white with pressure and vitreous base condensation were observed in five (55.6%) of nine cases that developed a retinal detachment. In one case inferior temporal white with pressure extended around the fundus periphery over a period of ten months to coalesce with a nasal band of white with pressure. During this period, condensation of the vitreous was observed. This condensation appeared ophthalmoscopically and biomicroscopically as a veil of fibers producing an optical density extending parallel to the ora serrata along the superior temporal anterior vitreous base. Two days following this examination a retinal detachment developed caused by two retinal tears along the adjacent inferior nasal bays of the ora serrata.

TABLE VI. NUMBER OF RETINAL TEARS IN THE FELLOW EYES OF GIANT RETINAL BREAKS (27 EYES)

No. of Tears	No. (%) Eyes
One	17 (63.0)
Two	4 (14.8)
Three	4 (14.8)
Four	1 (3.7)
Seven	1 (3.7)
TOTAL	27 (100.0)

d Management. All retinal detachments were treated with a scleral buckling with encircling element. Subretinal fluid was drained in 34 (94.4%) of 36 procedures.

Retinal Tears

a Incidence. Retinal tears without retinal detachment were present at the initial examination in 20 fellow eyes (8.8%). The incidence of retinal tears increased to 11.9% when seven (3.1%) eyes developed retinal tears during the follow-up (Table V).

b Morphology. Retinal tears showed a predisposition for the superior temporal quadrant (Fig. 2). The majority of the 27 fellow eyes contained one retinal tear (Table VI). The retinal tears were located in the oral region in 21 (77.8%) eyes and equatorially in six (22.2%) eyes. Most of the retinal tears were less than one disc diameter in size. Retinal tears were associated with lattice degeneration in four eyes (14.8%), marked white with pressure in 15 eyes (55.6%), and chorioretinal atrophy in two eyes (7.4%). No associated abnormal ophthalmoscopic findings were observed in four (14.8%) of the 27 eyes with retinal tears.

c Follow-Up. During the follow-up period, retinal tears developed in seven eyes. The average time for the diagnosis of the giant retinal break to diagnosis of the retinal tear was 43 months; the shortest latent period was nine months, the longest period five years. In all of these eyes, existing or new patches of white with pressure spread over the fundus periphery. In four eyes in which detailed biomicroscopy was performed, liquefaction, syneresis, and increasing condensation at the vitreous base were observed prior to the development of retinal tears.

Interesting changes were noted involving areas of white with pressure in one eye which developed multiple tears and a retinal detachment. At the initial examination, two bands of white with pressure were located superior and inferior temporally and confluent with the ora serrata. The posterior border of each band was

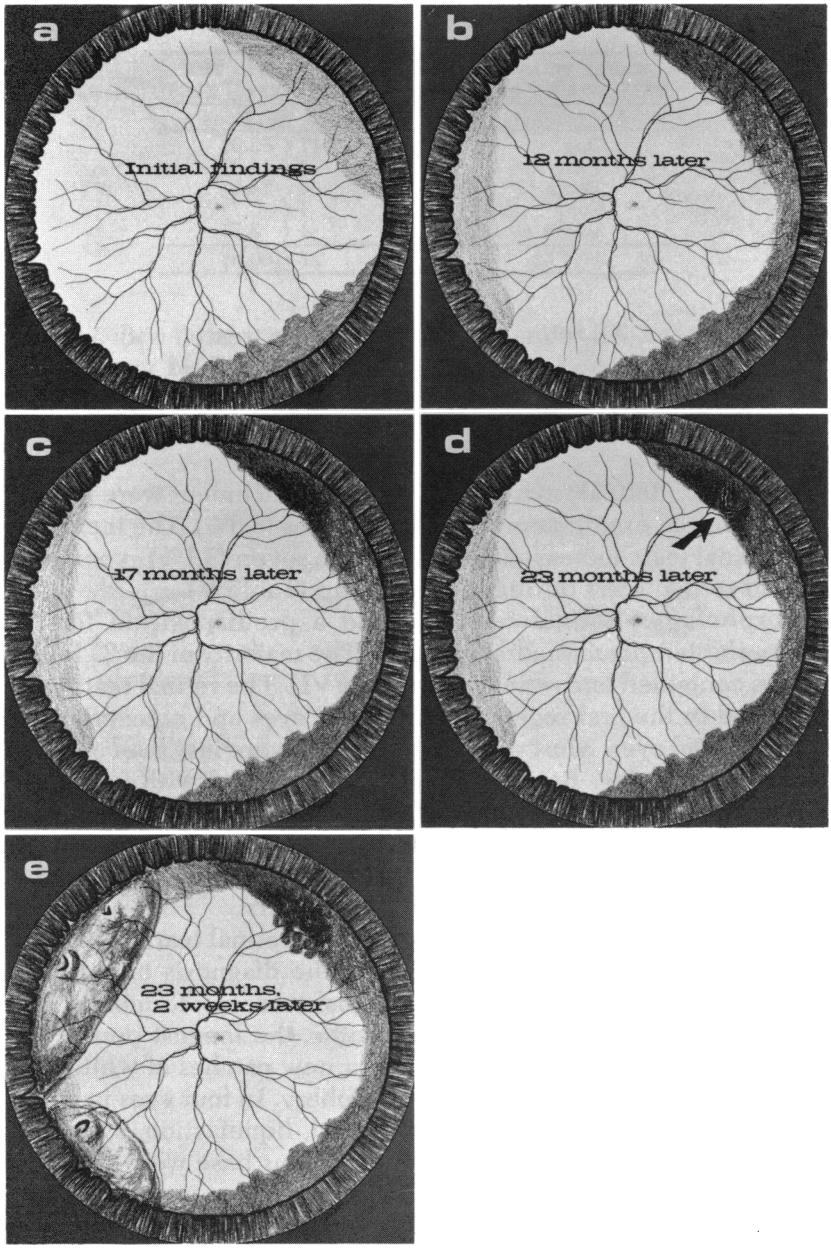

FIGURE 3

Progression of white with pressure. A: Initial examination: Retinal white with pressure borders the ora serrata from 12 to 3 o'clock and from 3:30 to 6 o'clock. B: Twelve months from the initial examination: Retinal white with pressure extends in

a confluent band from 12 to 6 o'clock. C: Seventeen months from the initial examination: The retinal white with pressure has become more dense from 1 to 2 o'clock and a new band of white with pressure has developed from 8 to 10:30 o'clock. D: Twenty-three months from the initial examination: A horseshoe tear (arrow) has developed in the 2 o'clock meridian within the white with pressure. E: Twenty-three months and two weeks after the initial examination: The horseshoe tear in the 2 o'clock meridian is surrounded with cryo pigmentation. Horseshoe tears have developed in the 8, 10, and 10:30 o'clock meridians surrounded by retinal detachment.

slightly wavy and indistinct and located in the region of the equator (Fig. 3A). One year later these bands had coalesced and the posterior border was more distinct. A new band of white with pressure was present between the 8 and 10 o'clock meridian (Fig. 3B). Seventeen months from the initial examination (Fig. 3C), the superior temporal white with pressure had become more dense. Twenty-three months and two weeks after the initial examination a horseshoe tear was present within the superior temporal white with pressure (Fig. 3D). The tear was treated with cryo applications. Two weeks later a total of three horseshoe tears developed in the 1, 2, and 3 o'clock meridians and produced a nasal retinal detachment. Inasmuch as the patient had a pupil which dilated poorly, it was impossible to correlate these progressive fundus changes with biomicroscopy of the vitreous.

d Management. There is no question that it is important and very desirable to have a control series of untreated retinal tears in fellow eyes of giant retinal breaks. Nonetheless I felt obliged to recommend treatment of all retinal tears because 21 (77.8%) of 27 patients with retinal tears were monocular, in addition to having an average of -9.00 diopters of myopia, and 22 (81.5%) had associated vitreous degeneration or shrinkage. Twenty-six of the 27 retinal tears were treated. One patient refused treatment and was lost to follow-up.

Prophylactic Transconjunctival Cryo. Ten eyes with a small retinal tear were treated with transconjunctival cryo. A retinal detachment developed in four of these eyes, occurring three weeks, five months, ten months, and two years after the initial examination. Two of these four eyes were aphakic as a result of surgery for congenital cataract, one was highly myopic (-15.00 D), and another eye had lattice-like degeneration. A scleral buckling procedure with encircling element was performed in these eyes.

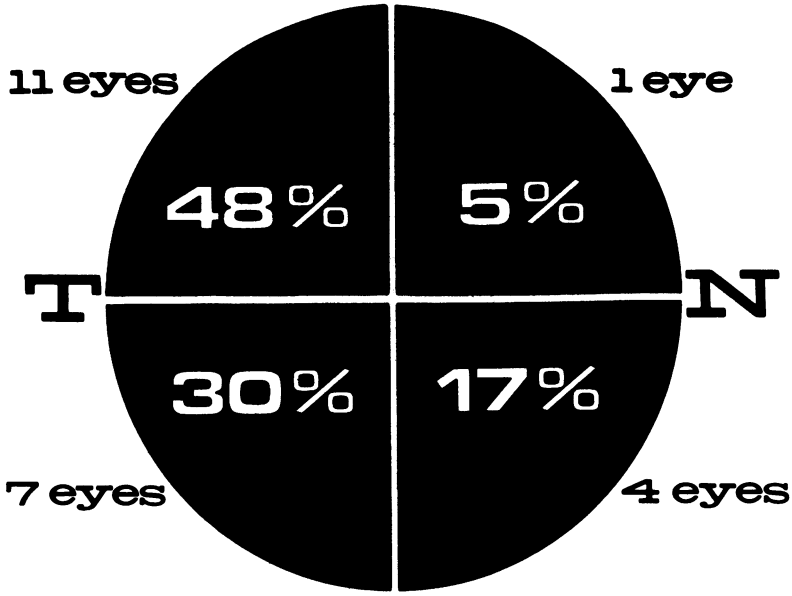

FIGURE 4
Location of retinal holes in fellow eyes of giant retinal breaks.

Prophylactic Scleral Buckling. Following the above experience, prophylactic scleral buckling with encircling element was performed on 16 eyes with retinal tears.

Retinal Holes

a Incidence. Retinal holes were present at the initial examination of 19 (8.4%) of 226 fellow eyes of giant retinal breaks. During the 16 years of observation, retinal holes developed in four (1.8%) additional eyes (Table 5).

b Morphology. The retinal holes were located in the superior temporal quadrant in 11 (47.8%) of these 23 eyes and were equally distributed above and below the horizontal meridian (Fig. 4). The retinal holes were located in the region of the equator in 13 (56.5%) eyes, the ora serrata in eight (34.8%) eyes, and in both regions in two (8.7%) eyes. The majority of eyes contained a single retinal hole (Table VII). The size of the holes varied from approximately 1/10 to 3/4 of a disc diameter, the majority being small. Holes were located in normal appearing retina in nine eyes, in areas of white with pressure in eight eyes, within lattice-

TABLE VII. NUMBER OF RETINAL HOLES IN THE FELLOW EYES OF GIANT RETINAL BREAKS (23 EYES)

No. of Holes	No. (%) Eyes
One	17 (73.9)
Two	4 (17.4)
Four	2 (8.7)
TOTAL	23 (100.0)

like degeneration in four eyes, and adjoining a pigment clump in two eyes. The vitreous showed minimal liquefaction in all eyes except the eye which also developed a retinal tear. This eye showed vitreous base condensation and extensive syneresis.

c *Follow-Up.* During the follow-up, four additional eyes of patients aged 64, 61, 59, and 24 years developed retinal holes nine, ten, 16, and 17 months after the onset of the giant retinal break in the presenting eye. White with pressure developed prior to the occurrence of retinal holes in three eyes. The retinal holes developed within the white with pressure in two eyes and adjacent to it in one eye. A small round hole developed posterior to an area of cryocoagulation pigmentation applied four months earlier to an area of lattice-like degeneration. Three patients experienced no symptoms, and one patient gave a nine day history of flashes in an eye which developed a retinal tear in addition to the hole.

d *Management.* Twenty (87.0%) of the 23 eyes with retinal holes were treated. Two eyes that were not treated were seen in the late 1960's prior to the advent of cryocoagulation or photocoagulation and the patients were lost to follow-up. No treatment was advised in another eye with a small hole adjacent to the ora serrata in the 6 o'clock meridian and unassociated with vitreous base condensation.

Transconjunctival cryocoagulation. Transconjunctival cryocoagulation was used to treat small holes occurring in 14 eyes with no visible vitreous base condensation.

Prophylactic Scleral Buckling. Scleral buckling with an encircling element was performed in six patients with retinal holes. Two of these six patients were monocular, highly myopic with a refractive error of -19.00 diopters and -16.00 diopters, had severe vitreous degeneration, and had extensive and progressing white with pressure. Two eyes that were buckled had severe lattice degeneration, increasing white with pressure, and vitreous base condensation. Two of the six eyes had both retinal tears and retinal holes.

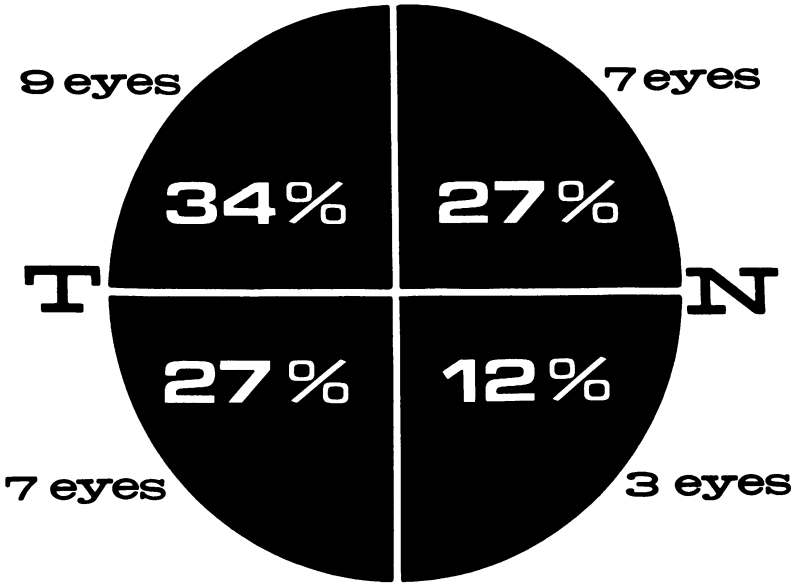

FIGURE 5
Location of lattice-like degeneration in fellow eyes of giant retinal breaks.

Retinal Dialysis

a Incidence. The incidence of retinal dialysis was extremely low in fellow eyes of giant retinal breaks occurring in only one patient (0.4%). The patient, a 10-year-old male, was highly myopic and phakic.

b Morphology. Two crescentic shaped retinal dialyses were present adjacent to two ora bays in the inferior temporal quadrant. The dialyses were located in an area of white with pressure which had a sharp posterior margin. The patient was uncooperative in an attempted biomicroscopic study of the vitreous with a three-mirror contact lens.

c Management. This retinal dialysis was treated with transconjunctival cryocoagulation.

Lattice-like Degeneration. Lattice-like degeneration was observed in 18 (8.0%) fellow eyes of a giant retinal break. Retinal tears were present in four (22.2%) of 18 eyes with lattice-like degeneration and retinal holes in four (22.2%) eyes.

A. *Lattice-like Degeneration Without Retinal Breaks.*

a Incidence. Lattice-like degeneration without retinal breaks was observed in 10 (4.4%) of 226 fellow eyes of giant retinal breaks.

b Morphology. Ophthalmoscopic examination revealed a total of 26 lattice-like areas located between the ora serrata and the equator in the ten eyes with lattice-like degeneration without retinal breaks. These areas showed a predisposition for the temporal and superior quadrants (Fig. 5). Islands of lattice-like degeneration were oval shaped with the long axis parallel to the ora serrata. Fifteen (57.7%) of the 26 islands of lattice were less than one hour in length, eight islands (30.6%) extended one to two hours of the clock, and three islands (11.5%) extended over two to three clock meridians. Thirteen areas of lattice-like degeneration appeared as grayish-white thinned retina, ten areas contained a white fishbone pattern, and three areas were deeply pigmented.

Biomicroscopic examination with the three-mirror contact lens revealed vitreous pathology consisting of syneresis, vitreoretinal adhesions along the margins of the lattice-like degeneration, and condensation of the vitreous base in six (60%) eyes. No vitreous pathology was detected by biomicroscopy in four (40%) of the eyes with lattice-like degeneration without retinal breaks.

c Follow-Up and Management.

Eyes Without Vitreous Pathology. Early in the study it was decided to refrain from prophylactic treatment of eyes with lattice-like degeneration unless a retinal break or vitreous pathology was present. Three of four patients in this category that have been followed from 28 months to five years have not developed retinal breaks; one patient from Australia was lost to follow-up.

Eyes with Vitreous Pathology. The six eyes with vitreous pathology associated with the lattice-like degeneration had severe white with pressure and were highly myopic, the average amount of myopia being -12.00 diopters. These factors, in addition to the lattice-like degeneration, prompted a decision to treat these six eyes with a scleral buckling and encircling element. One monocular 30-year-old woman chose not to be treated. The eye was highly myopic (-15.00 D), had marked condensation of the vitreous base,

and shrinkage of the vitreous gel associated with extensive syneresis. A dense band of frosted appearing white without pressure extended around the entire circumference of the fundus periophery in the region of the vitreous base. Four years later a 170 degree giant retinal tear developed. Four operations to reattach the retina were unsuccessful.

B. Lattice-like Degeneration and Retinal Tears.

a Incidence. Lattice-like degeneration and retinal tears were present in four (1.8%) of 226 fellow eyes of giant retinal breaks.

b Morphology. Retinal tears were present in four (17.4%) of the 23 eyes with lattice-like degeneration. These retinal tears were located at the posterior edge of the lattice-like degeneration in two eyes, along the anterior border of the lattice in one eye, and in a quadrant free of lattice-like degeneration in another. Three eyes contained a single retinal tear, two retinal tears were present in one eye.

Biomicroscopic examination with the contact lens revealed severe vitreous shrinkage and extensive liquefaction of the vitreous gel in all eyes with retinal tears. A dense vitreoretinal adhesion was present along the border of the lattice-like degeneration where the retinal tear developed. The retinal tear that developed outside the lattice-like degeneration occurred in an eye with marked shrinkage of the vitreous gel and condensation of the vitreous base. A posterior vitreous detachment extended to a prominent vitreoretinal adhesion that was attached to the flap of the retinal tear. This adhesion was continuous with the posterior border of the vitreous base.

c Follow-Up and Management. Prophylactic treatment was performed on the four fellow eyes with lattice-like degeneration and retinal tears.

Transconjunctival Cryocoagulation. The tear located in a quadrant separate from the lattice-like degeneration was treated with cryo. Increased condensation and shrinkage of the vitreous gel was noted during the following five months, then two large tears developed along the posterior border of lattice-like degeneration. These retinal tears were treated with a scleral buckling procedure. One eye with multiple retinal tears at the edge of lattice-like degeneration was treated with cryocoagulation by the referring ophthal-

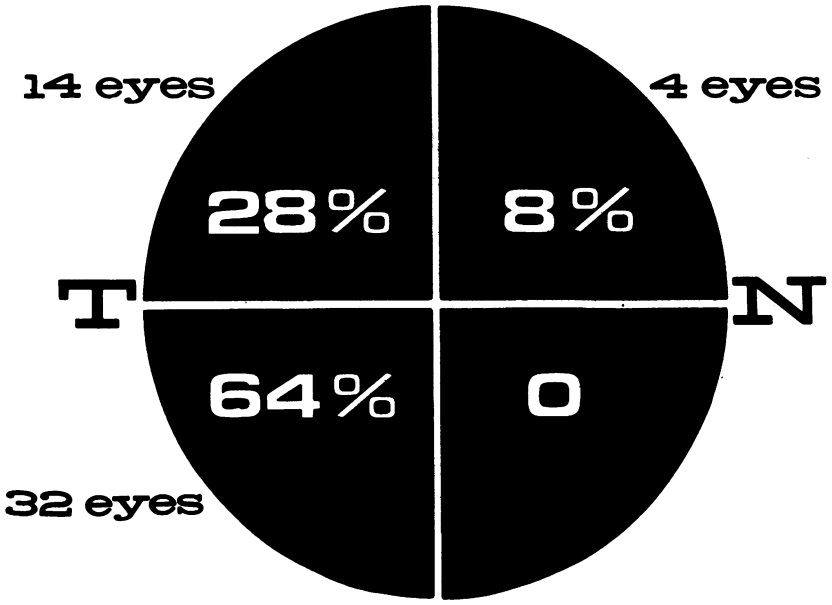

FIGURE 6
Location of chorioretinal atrophy in fellow eyes of giant retinal breaks.

mologist. A scleral buckling procedure was performed when additional multiple retinal tears developed.

Scleral Buckling. Two eyes with retinal tears bordering the lattice-like degeneration were treated with a scleral buckling operation.

C. Lattice-like Degeneration and Retinal Holes

a Incidence. Lattice-like degeneration with retinal holes was observed in four (1.8%) of 226 fellow eyes of giant retinal breaks.

b Morphology. Retinal holes were found within areas of lattice-like degeneration in four (17.4%) of 23 eyes with lattice-like degeneration. Three retinal holes were present in three eyes, four holes were observed in one eye. The holes were small, round or oval in shape, had smooth flat edges, and occurred in lattice-like degeneration in which the retina had become markedly thinned, atrophic, densely pigmented, and contained prominent white lattice-like lines. The vitreous gel in these eyes showed some syneresis and moderate shrinkage in three eyes and no shrinkage in one eye.

c *Follow-Up and Management.* Prophylactic treatment was performed on the four fellow eyes with lattice-like degeneration and retinal holes.

Transconjunctival Cryocoagulation. The retinal holes in the eyes with no evidence of vitreous shrinkage were treated with cryocoagulation.

Scleral Buckling. A scleral buckling procedure was performed in three eyes with vitreoretinal adhesions to the margin of the lattice-like degeneration, syneresis, and shrinkage of the vitreous gel.

Chorioretinal Atrophy

a *Incidence.* Chorioretinal atrophy was observed in 12 (5.3%) fellow eyes of patients with giant retinal breaks.

b *Morphology.* Atrophy of the choroid and retina appear as discrete areas of retinal and choroidal thinning. The edges of the atrophic areas were pigmented and the central atrophic portion of each area had a grey or white appearance. Fifty areas were located in the temporal quadrants (Fig. 6). Forty-eight (96%) of these chorioretinal lesions were located near the ora serrata and two (4%) were closer to the equator. The vitreous in ten (83.3%) of the 12 eyes with chorioretinal atrophy showed no degenerative changes. The two highly myopic eyes had extensive syneresis, liquefaction, and vitreous base condensation.

c *Follow-Up and Management.* No prophylactic treatment was performed on areas of chorioretinal atrophy. Retinal breaks developed during the follow-up in three (25%) of 12 fellow eyes with chorioretinal atrophy. A giant retinal break developed in an eye with severe myopic chorioretinal degeneration, a large posterior staphyloma, and a refractive error of −22.00 diopters. Two eyes that developed vitreous base condensation and extension of existing white with pressure developed a retinal tear five years after the initial examination in one eye and seven years later in the other eye.

Retinal White With Pressure Without Retinal Breaks or Chorioretinal Degeneration.

a *Incidence.* Retinal white with pressure in the absence of retinal breaks or chorioretinal degeneration occurred in 35 (15.5%) of 226 fellow eyes. Retinal white with pressure occurred in 11 (91.7%) of 12 fellow eyes with lattice-like degeneration, in 24

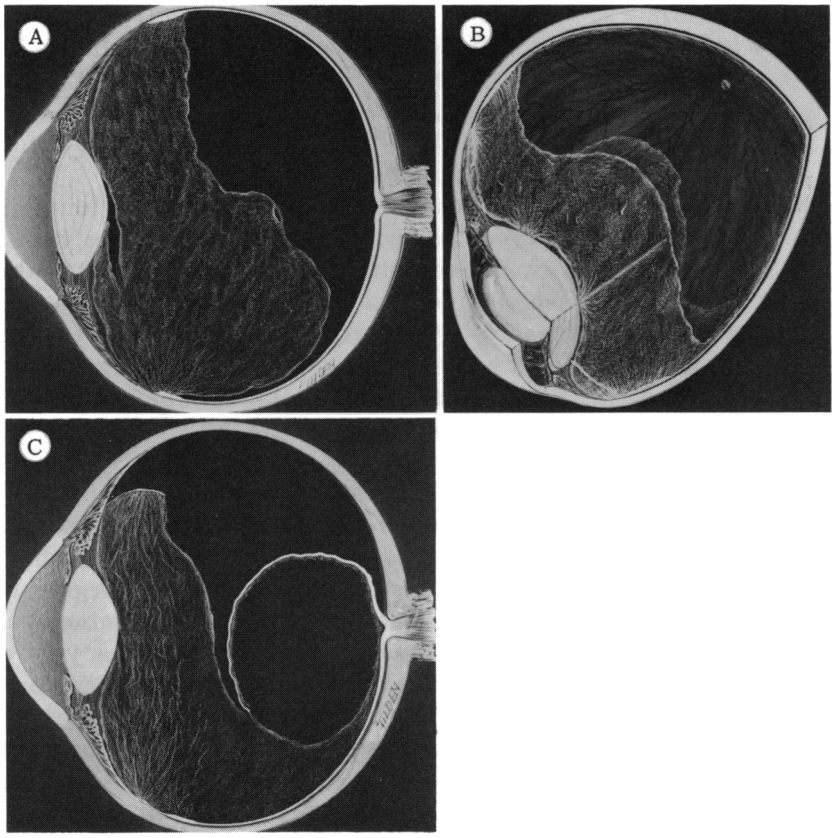

FIGURE 7

Posterior vitreous detachment is present with vitreous attached to retinal white with pressure bordering the ora serrata. B: Pseudodetachment of the vitreous is characterized by a large lacuna having a thin layer of vitreous cortex lining the posterior retina. The anterior vitreous is condensed. The anterior wall of the lacuna is formed by a condensation of the vitreous gel. C: Superior giant retinal break has an inverted retinal flap. The anterior edge of the giant retinal break is retracted by condensed vitreous gel and a membrane.

(88.9%) of 27 fellow eyes with retinal tears, in 15 (78.9%) of 19 fellow eyes with retinal holes, and in five (50%) of ten fellow eyes with chorioretinal atrophy.

b Morphology. The white with pressure that occurred in the absence of retinal breaks or chorioretinal degeneration or chorioretinal atrophy in 35 fellow eyes of giant retinal breaks will be described. Retinal white with pressure was confluent with the ora serrata in 17 (48.6%) eyes, it was present in islands between

the ora serrata and the region of the equator in eight (22.9%) eyes, and in both regions in 16 (45.7%) eyes. The retinal white with pressure extended through an arc of peripheral retina less than 90 degrees in four (11.4%) eyes, it involved from 90 to 180 degrees in 12 eyes (34.3%), from 180 to 270 degrees in four (11.4%) eyes, and more than 270 degrees in 15 (42.9%) eyes.

Liquefaction and syneresis of the vitreous body were found in all fellow eyes with retinal white with pressure. In eyes with a posterior vitreous detachment with collapse, detachment of the posterior cortex often stopped at a vitreoretinal adhesion at the posterior border of the white with pressure (Fig. 7A). In eyes with pseudodetachment of the vitreous characterized by a large lacuna (Fig. 7B), the vitreous base in the region of the retinal white with pressure showed extensive shrinkage of the gel which had contracted toward the ciliary body.

c *Follow-Up.* Retinal white with pressure was observed to increase in extent and density in nine (25.7%) of 35 eyes in which white with pressure was the only abnormal ophthalmoscopic finding. These nine eyes were highly myopic, the average degree of myopia was −12.00 diopters. In seven (77.8%) of these nine eyes the increasing retinal white with pressure took on a yellow frosted appearance. The surface of the retina lost its sheen and appeared dirty grey, roughened, and avascular. The frosted appearance extended varying distances posteriorly to the region of the equator or anteriorly to the ora serrata. The posterior border was irregular and indistinct. Extensive liquefaction, syneresis, and condensation of the vitreous base were present in all of these eyes. Retinal breaks developed in all of these eyes during the follow-up. A giant retinal break developed in six (66.7%) eyes, retinal tears developed in two (22.2%) eyes, and retinal detachment in one (11.1%) eye.

d *Management.* Following our experience that all of the highly myopic eyes with increasing white with pressure and progressive vitreous degeneration developed retinal breaks, a prophylactic scleral buckling was performed on 15 eyes with similar findings.

RESULTS

Results of treatment of the fellow eye will be discussed under: I. Giant Retinal Breaks; II. Retinal Detachment; III. Prophylactic

Treatment of Retinal Tears; IV. Prophylactic Treatment of Retinal Holes; V. Prophylactic Treatment of Retinal Dialysis; VI. Prophylactic Treatment of Lattice-like Degeneration; and VII. Prophylactic Treatment of Highly Myopic Eyes with Increasing White with Pressure and Severe Vitreous Pathology.

RESULTS IN FELLOW EYE GIANT BREAKS

Giant Retinal Breaks Present at Initial Examination

Thirteen (86.7%) of 15 fellow eyes with a giant retinal break present at the initial examination were operated. Two eyes were considered inoperable: one eye had a 360 degree giant break and massive preretinal retraction, the other eye had no light perception. The retina was reattached in eight (61.5%) eyes (Table VIII). Visual acuity obtained in the eight eyes in which the retina reattached was 20/40 or better in two (25%) eyes, 20/200 or better in four (50%) eyes, and less than 20/200 in two (25%) eyes.

Giant Retinal Breaks that Developed during Follow-Up

The retina was reattached in ten (71.4%) of the 14 eyes in which a giant retinal break developed during the follow-up (Table 8). Visual acuity obtained in ten eyes in which the retina was reattached was 20/50 or better in five eyes (50%), 20/200 in four eyes (40%), and hand movements vision in one (10%) eye.

RESULTS IN RETINAL DETACHMENT IN THE FELLOW EYE

Retinal Detachment at the Time of Diagnosis of Giant Retinal Break

Of 27 fellow eyes with a retinal detachment present at the time of diagnosis of the giant break in the other eye, 16 (59.3%) were considered inoperable. A scleral buckling with encircling element was performed in seven eyes. These eyes have been followed eighteen months or more and the retina has remained reattached in seven (100%) eyes. Visual acuity of 20/40 or better was obtained in

TABLE VIII. RESULTS IN FELLOW EYES OF BILATERAL GIANT RETINAL BREAKS (29 EYES)

	Success No. (%) Eyes	Failure No. (%) Eyes
Giant break present at initial examination	8 (61.5)	5 (38.5)
Giant break developed during follow-up	10 (71.4)	4 (28.6)

four (57.1%) of seven eyes in which the retina was reattached, while 20/50, 20/70, and 20/400 were obtained in the other three eyes. Successful scleral buckling surgery had been performed on four eyes prior to referral, and visual acuity of these eyes was 20/40, 20/50, 20/200, and 20/300.

Retinal Detachment that Developed during the Follow-Up Period

A scleral buckle with encircling element was performed on nine fellow eyes that developed a retinal detachment during the follow-up period. These eyes have been followed for a period greater than eighteen months and the retina has remained reattached in nine (100%) of them. Visual acuity of 20/30 or better was obtained in six eyes (66.7%), 20/200 or better was obtained in two (22.2%) eyes, and one eye (11.1%) that developed massive preretinal retraction requiring three operations to reattach the retina obtained 20/400.

PROPHYLACTIC TREATMENT OF RETINAL TEARS

Transconjunctival Cryocoagulation

Six (60%) of the ten eyes with a small single retinal tear that was treated with cryocoagulation have not developed additional retinal breaks during the follow-up period of three to 11 years. Pretreatment visual acuity has been maintained in all of these eyes.

Four (40%) of ten eyes prophylactically treated with cryocoagulation developed additional retinal breaks and retinal detachment. Tears in these eyes were associated with lattice degeneration, high myopia, vitreous degeneration or congenital aphakia. Scleral buckling was successful in reattaching the retina in three eyes; postoperative visual acuity of 20/20 was obtained in two eyes, 20/100 was obtained in the third eye.

Prophylactic Scleral Buckling

The retina remained attached and no new retinal breaks developed in 15 (93.8%) of 16 eyes with retinal tears in which prophylactic scleral buckling was performed. One patient with Wagner degeneration developed a giant retinal break that was reattached with a second scleral buckling. With the exception of this case which obtained a visual acuity of 6/30, the preoperative visual acuity has been maintained in 15 of 16 eyes during the follow-up period of three to 11 years.

PROPHYLACTIC TREATMENT OF RETINAL HOLES

Transconjunctival Cryo

Small retinal holes situated near the ora serrata in 14 eyes were successfully sealed with cryocoagulation. Pretreatment visual acuity was maintained over the follow-up period which ranged from 21 months to eight years.

Prophylactic Scleral Buckling

Six eyes with retinal holes and vitreous or chorioretinal degeneration that were prophylactically treated with a scleral buckle have been followed for periods of 18 months to 11 years. The retina has remained attached, preoperative visual acuity has been maintained, and no new retinal breaks have developed in these six eyes.

PROPHYLACTIC TREATMENT OF RETINAL DIALYSIS

Transconjunctival Cryocoagulation

The patient with a retinal dialysis that was treated with transconjunctival cryocoagulation has been followed for three years during which time no new retinal breaks have developed and visual acuity has been maintained at the pretreatment level.

PROPHYLACTIC TREATMENT OF LATTICE-LIKE DEGENERATION

Lattice-like Degeneration without Retinal Breaks

Five of six fellow eyes with lattice-like degeneration and vitreous pathology were treated prophylactically with a scleral buckling. These five eyes have been followed from two to eight years, during that period the retina has remained attached and visual acuity has been maintained at the preoperative level.

Lattice-like Degeneration and Retinal Tears

a *Transconjunctival Cryocoagulation.* One small tear which developed in a quadrant away from the lattice-like degeneration was treated with cryocoagulation. Five months later a retinal detachment developed with large tears along the posterior edge of two areas of lattice-like degeneration that had been treated with cryocoagulation. A scleral buckling procedure was performed, however massive preretinal retraction developed postoperatively. Four scleral buckling operations were unsuccessful in reattaching the retina.

b Prophylactic Scleral Buckling. Retinal tears occurring along the border of lattice-like degeneration in three eyes were treated with a scleral buckling procedure. In two of these eyes the retina has remained reattached and preoperative visual acuity has been maintained during the follow-up period of five years for one eye and seven years for the other. The third patient was a 13-year-old monocular boy patient with Wagner degeneration, myopia of −14.00 diopters with severe vitreous shrinkage, condensation at the vitreous base and numerous vitreous membranes attached to the retina. His sister and mother were blind as a result of Wagner degeneration and retinal detachment. A giant retinal tear developed three years following a prophylactic scleral buckling procedure for the retinal tear. The retina was reattached with a revision of the scleral buckling and visual acuity of 6/30 has been maintained during the two year follow-up.

Lattice-like Degeneration and Retinal Holes

a Transconjunctival Cryocoagulation. Retinal holes in the eye in which no vitreous pathology was found by biomicroscopic examination were treated with cryocoagulation. Pretreatment visual acuity has been maintained and the retina has remained attached during the five year follow-up.

b Prophylactic Scleral Buckling. The three eyes with lattice-like degeneration with retinal holes that were treated with a scleral buckling procedure have maintained preoperative visual acuity and the retina has remained attached during the follow-up periods of five, seven, and eight years.

PROPHYLACTIC TREATMENT OF HIGHLY MYOPIC EYES WITH INCREASING WHITE WITH PRESSURE AND SEVERE VITREOUS PATHOLOGY

Prophylactic Scleral Buckling

The 15 highly myopic eyes with severe vitreous degeneration and increasing white with pressure that were prophylactically buckled have been followed for 18 months to eight years with an average follow-up of five years. There were no operative complications. A postoperative vitreous hemorrhage which cleared within two days of surgery was noted in one eye. Preoperative visual acuity has been maintained and no retinal breaks have developed in these 15 eyes.

DISCUSSION

AGE AND SEX

The majority of patients with giant retinal breaks are affected relatively earlier in life than patients with phakic or aphakic rhegmatogenous retinal detachments having all sizes of retinal breaks.[17–20] The trend of ideopathic retinal detachments to affect men more frequently than women was strikingly apparent in that 82.3 percent of the patients with a giant retinal break were male.[21–25] This preponderance in men and the early onset in life is in keeping with other observations that the severity of retinal disease increases with the propensity in men and early onset.[21,22]

APHAKIA

Aphakia Following Congenital Cataract Surgery

This series illustrates the poor long term prognosis of fellow eyes of giant retinal breaks in eyes in which surgery for congenital cataract has been performed. Giant retinal breaks, retinal detachment, retinal tears, retinal holes, or retinal dialysis were observed in 17 (89.5%) of 19 fellow eyes in this category. Four of these eyes are phthisical and the retina remains attached in only seven (36.8%) eyes.

Aphakia Following Surgery for Senile Cataracts

A comprehensive study involving cataract extraction in the retinal detachment prone patient demonstrated the value of prophylactic therapy in such eyes.[26] In addition, a recent study of unilateral aphakic retinal detachment supported this view by reporting that the chances of retinal detachment in the fellow eye are increased fourfold by cataract extraction. The authors concluded that the risk of retinal detachment in the fellow eye is decreased by prophylactic treatment of full thickness retinal breaks and lattice-like degeneration.[27] The high incidence of retinal breaks, retinal detachment, and chorioretinal degeneration in the fellow eye of giant retinal breaks places these patients in a very high risk category with regards to cataract extraction. In view of these studies and our findings, it seems justified to perform prophylactic treatment on retinal breaks prior to lens extraction in fellow eyes of giant retinal breaks.

REFRACTIVE ERROR

In this series the 81.1 percent incidence of myopia was significantly greater than in the general population[2,3,21,28–30] and higher than in reported series of retinal detachments.[31–33] The small number of women makes it impossible to draw statistical conclusions with regard to sex and refractive error.

VITREORETINAL FINDINGS

High Incidence of Vitreoretinal Pathology.

Ophthalmoscopic and biomicroscopic findings of this study demonstrate the high incidence of vitreoretinal pathology in the fellow eyes of nontraumatic giant retinal breaks. By the end of the period of observation, retinal detachment or retinal breaks without retinal detachment had developed in 51.3 percent of fellow eyes (Table 5).

Importance of Follow-Up Examinations.

Early diagnosis probably played an important role in achieving better results in the retinal detachments and giant retinal breaks that developed in the fellow eye. For these reasons one should insist on regular follow-up examinations of all fellow eyes even though they may appear normal at the initial examination. Six (17.1%) of the 35 normal appearing fellow eyes developed retinal breaks including one giant retinal break that could not be reattached. The follow-up of fellow eyes that subsequently developed a giant retinal break indicates that the five year period following the development of a giant retinal break in one eye is a critical period for the fellow eye. It seems prudent that during the five year period following a giant retinal break in one eye, the fellow eye be examined at least every six months with subsequent examinations at intervals of a year or less.

The Significance of Vitreous Base Condensation and Increasing White with Pressure.

The findings of vitreous base condensation and increasing white with pressure in the fellow eyes that subsequently developed a giant retinal break incriminate vitreous traction in the pathogenesis of giant retinal breaks. Follow-up of these eyes showed that vitreous traction was preceded by syneresis and liquefaction of the vitreous gel. In the early stages, the posterior and middle portions of the vitreous body were converted into a large lacuna while the anterior gel became condensed. The anterior wall of the lacuna was

formed by a condensation membrane extending across the equatorial region separating the anterior gel from the liquefied vitreous (Fig. 7B). This membrane was often somewhat rigid and did not oscillate with ocular movement suggesting that it was under traction between its points of attachment to the vitreous base and areas of white with pressure (Fig. 7). Severe contraction of this membrane may be what tears the retina in that this membrane is seen attached to the anterior edge of the giant retinal break (Fig. 7C). The white with pressure that increased in extent and density may be a result of increasing vitreous base condensation. These findings indicate that areas of white with pressure should be carefully studied in order to determine whether they are increasing in size and density. The use of an acetate overlay over the initial large fundus drawing has proved especially useful in recording white with pressure. Recording not only the extent but the density of the white with pressure is helpful for comparison at future examinations. The density of the white with pressure may be graded + to ++++ depending on the amount of opacification of the retina. When one can document increasing white with pressure in conjunction with increasing vitreous base condensation, then prophylactic scleral buckling to relieve vitreous traction should be seriously considered. If symptoms of flashes are present as was the case in the patient illustrated in Figure 1, then giant retinal break formation may be imminent.

ANALYSIS OF FELLOW EYES NOT TREATED PROPHYLACTICALLY

It is helpful to analyze the natural course of untreated eyes in order to have a basis for comparison with eyes treated prophylactically. One hundred twenty-four fellow eyes were followed and were not treated prophylactically (Table IX). This untreated group consisted

TABLE IX. OPHTHALMOSCOPIC FINDINGS IN FELLOW EYES NOT TREATED PROPHYLACTICALLY (124 EYES)

	No. (%) Eyes
Normal appearing fundus	49 (39.6)
White with pressure	35 (28.2)
Chorioretinal atrophy	12 (9.7)
Lattice-like degeneration	5 (4.0)
Retinal hole	3 (2.4)
Retinal tear	1 (0.8)
Fundus periphery not well visualized	19 (15.3)
TOTAL	124 (100.0)

TABLE X. PROGRESSION TO RETINAL BREAKS OR DETACHMENT IN EYES NOT TREATED PROPHYLACTICALLY (124* EYES)

	Initial Examination No. Eyes	Progression No. Eyes	Incidence Of Progression (%)
Normal appearing	49	6	12.2
White with pressure	35	9	25.0
Chorioretinal atrophy	12	3	25.0
Lattice-like degeneration	5	2	40.0
Fundus periphery not well visualized	19	15	78.9
TOTAL	120	35	

*The eye with the retinal tear and an eye with a retinal hole were lost to follow-up; there was no progression to retinal detachment in two eyes with a small, inferior hole located near the ora.

of 49 (39.5%) eyes with a normal appearing fundus, 35 (28.2%) eyes with white with pressure, 12 (9.7%) eyes with chorioretinal atrophy, five (4%) eyes with lattice-like degeneration and no retinal breaks nor abnormal vitreoretinal adhesions, three (2.4%) eyes with a retinal hole, and one (0.8%) eye with a retinal tear. The fundus periphery could not be visualized in 19 (15.3%) eyes as a result of cataractous changes or lens remnants following surgery for congenital cataract.

Follow-Up

During the period of observation which varied from 18 months to 16 years, retinal breaks or retinal detachment developed in 35 (28.2%) of the 124 eyes (Table X). The majority of retinal breaks that developed were giant retinal breaks occurring in 14 (40%) of the 35 eyes (Table XI). Retinal breaks developed in six (12.2%) of 49 fellow eyes which appeared normal by ophthalmoscopy at the initial examination. Nine (25.7%) of 35 eyes with white with pressure developed retinal breaks.

The fellow eyes which showed the most severe and highest incidence of progression were highly myopic eyes with increasing

TABLE XI. RETINAL BREAKS AND DETACHMENT THAT DEVELOPED IN EYES NOT PROPHYLACTICALLY TREATED (35 EYES)

	No. (%) Eyes
Giant break	14 (40.0)
Retinal detachment	8 (22.9)
Retinal tear	7 (20.0)
Retinal hole	4 (11.4)
Retinal dialyses	2 (5.7)

white with pressure and increasing condensation at the vitreous base. During the follow-up of nine such eyes, retinal breaks including six giant breaks or retinal detachment developed in all of them (Table XII). The 37.9 percent incidence of retinal breaks that developed in eyes which appeared normal by ophthalmoscopy or had white with pressure at the initial examination (Table X), indicates that all fellow eyes should be followed regardless of the benign appearing initial findings.

Incidence of Progression

The 28.2 percent incidence of retinal breaks, 40 percent of which were giant retinal breaks (Table XI), which developed in untreated eyes indicates that fellow eyes of nontraumatic giant retinal breaks are in a high risk category. This and other studies of the natural history of retinal breaks without retinal detachment reveal that the incidence of retinal breaks increases with the length of follow-up.[34,35] It must be emphasized that the follow-up period of this study represents a period of 16 years at most. Though the study began 16 years ago, the average length of follow-up was 3.7 years because the majority of cases were added during recent years: for example, 62 percent of the cases were added during the past five years. The relatively short average follow-up of 3.7 years is also accounted for by the fact that only the successful monocular cases returned for follow-up and the majority of foreign patients, which comprise eight percent of the patients, were lost to a long follow-up.

Results of Treatment of Eyes Not Treated Prophylactically which Developed Retinal Breaks or Detachment

When considering prophylactic treatment with its attendant risks, it is important to analyze the anatomical and visual results of treat-

TABLE XII. INCIDENCE OF RETINAL BREAKS AND RETINAL DETACHMENT THAT DEVELOPED IN UNTREATED EYES WITH HIGH MYOPIA, VITREOUS DEGENERATION, AND INCREASING WHITE WITH PRESSURE (9 EYES)

	No. (%) Eyes
Giant retinal breaks	6 (66.7)
Retinal detachment	1 (11.1)
Retinal holes	2 (22.2)
TOTAL	9 (100.0)

TABLE XIII. RESULTS OF TREATMENT OF RETINAL BREAKS, OR DETACHMENT, OR VITREORETINAL PATHOLOGY THAT DEVELOPED IN EYES NOT PROPHYLACTICALLY TREATED (44 EYES)

	Retina Attached No. (%) Eyes	Failure No. (%) Eyes
Giant retinal breaks	10 (71.4)	4 (28.6)
Retinal detachment	8 (88.9)	1 (11.1)
Retinal tears and holes	12 (100.0)	0 (0.0)
Increasing white with pressure, high myopia, and vitreous shrinkage	6 (66.7)	3 (33.3)
TOTAL	34 (77.3)	10 (22.7)

ment of retinal breaks or detachment which developed in eyes that were not treated prophylactically.

a Anatomical Results. Anatomical results of treatment performed on retinal breaks and retinal detachment that developed in eyes not prophylactically treated are listed (Table XIII). The retinal breaks were effectively sealed and the retina was reattached in 34 (77.3%) of 44 treated eyes. The retina could not be reattached in one eye with lattice-like degeneration and retinal detachment and in three highly myopic eyes that showed increasing white with pressure and vitreous base condensation prior to the development of retinal breaks or detachment. Unfavorable anatomical results were obtained in the treatment of retinal breaks or detachment in highly myopic eyes with increasing white with pressure and vitreous base condensation. Retinal reattachment was obtained in only six (66.7%) of nine eyes.

b Visual Results. Though the retina was reattached in 71.4 percent of the giant retinal breaks, only one (10%) of ten eyes in which the retina was reattached obtained the level of visual acuity present prior to the onset of the giant break. Six (60%) of these ten eyes obtained 20/200 or less. A similar reduction in visual acuity occurred in three (33.3%) of nine eyes operated for a retinal detachment not caused by a giant retinal break. Though the retina has remained attached following the treatment of the 12 eyes with retinal breaks without detachment, two eyes required two scleral buckling procedures and the visual acuity was reduced from 20/20 to less than 20/70 in two (16.7%) of these 12 eyes. Very unfavorable visual results were obtained following the treatment of retinal breaks or retinal detachment that developed in the highly myopic eyes with increasing white with pressure and vitreous base condensation. Only three (33.3%) of these nine eyes achieved the visual acuity equal to that prior to the

TABLE XIV. ANALYSIS OF PROPHYLACTICALLY TREATED EYES (55 EYES)

	Success No. (%) Eyes	Failure No. (%) Eyes
Retinal Tears	15 (100.0)	0 (0.0)
Retinal Holes	16 (100.0)	0 (0.0)
Retinal Tears with Lattice-like Degeneration	3 (75.0)	1 (25.0)
Retinal Holes and Lattice-like Degeneration	4 (100.0)	0 (0.0)
Retinal Dialysis	1 (100.0)	0 (0.0)
Lattice-like Degeneration, High Myopia, and Severe White With Pressure	5 (83.3)	1 (16.7)
High Myopia, Increasing White With Pressure, and Vitreous Base Condensation	9 (100.0)	0 (0.0)
TOTAL	53 (96.4)	2 (3.6)

onset of the retinal break or detachment. Visual acuity which was 20/30 or better in these nine eyes prior to the development of retinal break or a detachment was reduced to 20/200 or less in three eyes and three (33.3%) eyes became blind.

ANALYSIS OF PROPHYLACTICALLY TREATED FELLOW EYES

Anatomical Results

The retina has remained attached in 53 (96.4%) of 55 fellow eyes treated prophylactically (Table XIV). The incidence of operative or post-operative complications was low, a transient vitreous hemorrhage was noted postoperatively in one (1.8%) of the 55 treated eyes. This eye, which has been followed four years, achieved the preoperative level of visual acuity.

Functional Results

The pretreatment visual acuity has been obtained in 53 (96.4%) of 55 eyes treated prophylactically.

COMPARISON OF EYES TREATED PROPHYLACTICALLY WITH UNTREATED EYES

Incidence of Progression to Retinal Breaks or Retinal Detachment

During this study retinal breaks or retinal detachment developed in 35 (27.3%) of 128 untreated eyes and in two (3.6%) of 55 prophylactically treated eyes. A giant retinal break developed in ten (7.8%) of 128 untreated eyes and in one (1.8%) of 55 eyes treated prophylactically.

Retinal breaks including six giant breaks developed in all (100%) of the nine untreated eyes that were highly myopic, had increased white with pressure and increasing condensation of the vitreous

base. No retinal breaks developed in a similar group of 15 eyes treated with prophylactic scleral buckling.

Anatomical Results

The retina has remained attached in 53 (96.4%) of 55 eyes treated prophylactically. Treatment was performed on retinal breaks or retinal detachment that developed in 35 or 124 eyes that were followed and not treated prophylactically. The retina has remained attached in 120 (96.8%) of these 124 eyes following treatment of the retinal breaks or detachment.

The retina has remained attached in highly myopic eyes with increasing white with pressure and vitreous base condensation in 15 (100%) of 15 prophylactically treated eyes and in six (66.7%) of nine eyes not treated prophylactically.

Functional Results

Pretreatment visual acuity has been maintained in 53 (96.4%) of 55 eyes treated prophylactically and in 110 (88.7%) of 124 eyes not treated prophylactically, 35 of which developed retinal breaks or detachment that were treated. A postoperative diminution in visual acuity occurred in two (3.6%) of 55 eyes treated prophylactically and in 14 (40%) of 35 eyes not treated prophylactically which developed retinal breaks or detachment. The diminution in visual acuity was to the 20/100 level in two (3.6%) of the 55 eyes prophylactically treated group and in seven (20%) of the 35 eyes in the latter group.

CURRENT INDICATIONS FOR PROPHYLACTIC TREATMENT OF THE FELLOW EYE

Fellow Eyes With Congenital Aphakia

Because of the high (89.5%) incidence of retinal breaks and retinal detachment and the poor (36.8%) reattachment rate in the fellow eyes of giant retinal breaks in which congenital cataract surgery has been performed, prophylactic surgery for retinal breaks should be strongly considered.

Retinal Holes

When multiple holes or vitreous degeneration are present in a fellow eye of a giant retinal break, then prophylactic treatment

seems prudent. I am inclined to observe a small single retinal hole occurring near the ora serrata in an eye lacking vitreous shrinkage.

Retinal Tears

I treat retinal tears in fellow eyes of giant retinal breaks because of the guarded prognosis for the eye with the giant break; the propensity for tears to produce retinal detachment especially when vitreous degeneration and shrinkage are present as was observed in this series.

Lattice-like Degeneration, High Myopia, and Retinal Breaks

The prognosis of retinal detachment and especially giant retinal breaks in eyes with lattice-like degeneration is poor when the lattice-like degeneration is associated with severe vitreous degeneration. For that reason I have chosen to treat the retinal breaks if the lattice-like degeneration is associated with vitreous base condensation, shrinkage of vitreous gel, and vitreous adhesions to the lattice.

High Myopia, Increasing White With Pressure, Increasing Condensation of the Vitreous Base

The high incidence of retinal breaks (100%) and unfavorable anatomical and functional results of the treatment of retinal breaks which develop in eyes with myopia in excess of −10.00 diopters, increasing white with pressure, and increasing condensation of the vitreous base have prompted me to prophylactically treat such eyes. Results thus far are encouraging in that no retinal breaks have developed in 15 prophylactically treated eyes while there has been a 100% incidence of retinal breaks in a similar group of untreated eyes.

METHODS OF TREATMENT

Results in this study suggest that cryotherapy is satisfactory for the prophylactic treatment of retinal holes and retinal pathology. In order to relieve some of the vitreous traction, scleral buckling with an encircling element was used in the prophylactic treatment of retinal tears, lattice-like degeneration in eyes with high myopia and retinal breaks, and in eyes with high myopia, increasing white with pressure, and increasing condensation of the vitreous base.

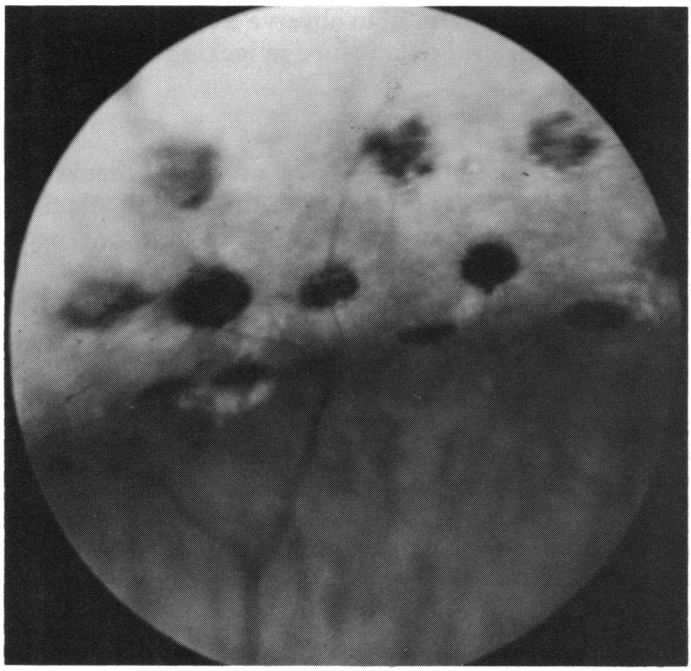

FIGURE 8
Fundus photograph of a scleral buckle showing the leopard skin appearance of diathermy spaced approximately 2 mm apart.

TECHNIQUE OF PROPHYLACTIC SCLERAL BUCKLING

Inasmuch as an osmotic agent and a carbonic anhydrase inhibitor are used to lower the intraocular pressure during surgery, a Foley catheter is inserted into the bladder preoperatively in adults and under general anesthesia in children. A light diathermy mark is made to localize the posterior edge of retinal tears, lattice-like degeneration, or white with pressure. In eyes where the sclera is of normal thickness, an 8 mm lamellar scleral undermining is performed in an attempt to buckle approximately 180 to 240 degrees of the globe selecting an arc which encompasses the most vitreoretinal pathology. Using a blunt conical electrode and low intensity current, diathermy applications are placed 2 mm apart in the scleral bed. In order to avoid damaging the long posterior ciliary arteries or nerves, their location is determined by transillumination of the sclera. To obtain a uniform and light diathermy reaction on the fundus, applications should be frequently monitored with indirect

ophthalmoscopy. The relatively wide spacing of the diathermy is designed to decrease the amount of scleral shrinkage which tends to elevate intraocular pressure and to minimize the area of vitreoretinal reaction. Postoperatively, properly spaced diathermy produces a leopard skin appearance with a substantial area of intact choroid and retina between the pigmented scars (Fig. 8). Three or four mattress sutures per quadrant are placed through the scleral flaps. A grooved silicone rubber implant 6 mm in width and 2 mm in thickness is placed in the lamellar scleral bed. In order to provide a permanent buckling effect, a circling band is inserted in the groove of the implant and around the globe. The mattress sutures are gently tightened and tied in a slip knot while the intraocular pressure and patency of the ophthalmic artery are carefully monitored. If the combination of carbonic anhydrase inhibitor and osmolytic agent have failed to lower the intraocular pressure sufficiently, then it can be lowered with repeated paracentesis. In most eyes, syneresis fluid which percolates into the anterior chamber can be removed from the eye to produce the moderate buckling effect desired. The encircling band and sutures are also adjusted so that the closing intraocular pressure does not exceed 25 mm of mercury. An anchoring suture is placed over the encircling band near the middle of the untreated quadrant of the globe.

In eyes with thin sclera, two rows of extremely light cryocoagulation are applied over the arc previously described and external buckling is performed with a grooved silicone implant and encircling element.[36]

SUMMARY

INCIDENCE OF RETINAL BREAKS AND DETACHMENT IN FELLOW EYES.

The fellow eyes of 226 giant retinal breaks were followed in order to determine the incidence and natural course of chorioretinal and vitreous pathology. During the period of observation which ranged from 18 months to 16 years, the incidence of retinal breaks and retinal detachment increased from 36.1 percent to 51.3 percent. By the end of the follow-up period, the incidence of bilateral giant retinal breaks was 12.8 percent; retinal tears 11.9 percent, retinal holes 10.2 percent, retinal dialysis 0.4 percent, and retinal detachment 15.9 percent. The average duration of follow-up was 3.7 years, therefore, the incidence of retinal breaks in fellow eyes is probably significantly higher.

VITREORETINAL CHANGES PRECEDING THE DEVELOPMENT OF RETINAL BREAKS.

Syneresis, liquefaction, and condensation of the vitreous base were observed in the majority of fellow eyes that developed retinal tears or giant retinal breaks. Follow-up of fellow eyes revealed that the development of a giant retinal break is often preceded by increasing white with pressure associated with increasing condensation of the vitreous base.

MANAGEMENT OF FELLOW EYES.

Because of the high incidence of retinal breaks developing in the fellow eye, regular and thorough examination of the vitreous and retina are mandatory on the fellow eyes of all nontraumatic giant retinal breaks even though the fundus may appear normal at the initial examination.

PROPHYLACTIC TREATMENT.

This study suggests that prophylactic treatment is beneficial in the management of fellow eyes of giant retinal breaks. During this study, retinal breaks developed in 27.3 percent of untreated eyes and in 2.4 percent of eyes treated prophylactically.

PROPHYLACTIC TREATMENT OF FELLOW EYES OF GIANT RETINAL BREAKS.

It seems prudent to prophylactically treat retinal holes or dialyses in eyes without retinal detachment with cryotherapy. Scleral buckling seems justified in the prophylactic treatment of eyes with retinal tears or lattice-like degeneration with retinal breaks or highly myopic eyes with increasing white with pressure and increasing condensation of the vitreous base.

REFERENCES

1. Freeman HM: Treatment of giant retinal tears, in McPherson A (ed): *New and Controversial Aspects of Retinal Detachment.* New York, Harper and Row, 1968, Chapt 39, pp 391-399.
2. Michaelson IC, Stein R (Coordinators) et al: A national cooperative study in the prevention of retinal detachment: A preliminary report. Acta XIX Concilium Ophthalmologicum 2:1356-1362, 1962.
3. Kreiger AE, Hodgkinson BJ, Frederick AR, et al: The results of retinal detachment surgery. Analysis of 268 operations with a broad scleral buckle. *Arch Ophthalmol* 86:385-394, 1971.
4. Norton EWD: Present status of cryotherapy in retinal detachment surgery. *Trans Am Acad Ophthalmol Otolaryngol* 73:1029-1034, 1969.

5. Schepens CL, Dobbie JG, McMeel JW: Retinal detachment with giant breaks: Preliminary Report. *Trans Am Acad Ophthalmol Otolaryngol* 66:471-479, 1962.
6. Schepens CL, Freeman HM, Thompson RF: A power-driven multipositional operating table. *Arch Ophthalmol* 73:671-673, 1965.
7. Schepens CL, Freeman HM: Current management of giant retinal breaks. *Trans Am Acad Ophthalmol Otolaryngol* 71:474-487, 1967.
8. Freeman HM: The treatment of giant retinal tears, in McPherson A (ed): *New and Controversial Aspects of Retinal Detachment.* New York, Harper and Row, 1968, pp 391-399.
9. Freeman HM: Current management of giant retinal breaks, in *Symposium on Retina and Retinal Surgery. Transactions of the New Orleans Academy of Ophthalmology.* St. Louis, Mosby, 1969, pp 171-183.
10. Tolentino FI, Schepens CL, Freeman HM: Closed vitreous surgery: Mechanical lysis of retinal synechia, in Schepens CL et al (ed): *Vitreoretinal Disorders Diagnosis and Management.* Philadelphia, W.B. Saunders, 1976, pp 589-600.
11. Norton EWD, Aaberg TM, Fung W, et al: Giant retinal tears: I. Clinical management with intravitreal air. *Am J Ophthalmol* 68:1011-1021, 1969.
12. Machemer R, Aaberg T, Norton EWD: Giant retinal tears: II. Experimental production and management with intravitreal air. *Am J Ophthalmol 68:1022-1029, 1969.*
13. Kanski JJ: Giant retinal tears. *Am J Ophthalmol* 79:846-852, 1975.
14. Freeman HM: Management of giant retinal breaks, in Pruett RC, Regan CDJ (eds): *Retina Congress.* New York, Appleton-Century-Crofts, 1974, pp 453-463.
15. Machemer R, Allen AW: Retinal tears 180° and greater. *Arch Ophthalmol* 94:1340-1346, 1976.
16. Hovland KR, Schepens CL, Freeman HM: Developmental giant retinal tears associated with lens coloboma. *Arch Ophthalmol* 80:325-331, 1968.
17. Norton EWD: Retinal detachment in aphakia. *Am J Ophthalmol* 58:111-124, 1964.
18. Bagley CH: Retinal detachment: A survey of the etiology and results of treatment on phakics and aphakics. *Am J Ophthalmol* 31:285-298, 1948.
19. Ashrafzadeh MT, Schepens CL, Elzeneiny II, et al: Aphakic and phakic retinal detachment: I. Preoperative findings. *Arch Ophthalmol* 89:476-483, 1973.
20. Schepens CL, Marden D: Data on the natural history of retinal detachment. Further characterization of certain unilateral nontraumatic cases. *Am J Ophthalmol* 61:213-226, 1966.
21. Robertson RW: Statistical study of retinal detachment. *Trans Can Ophthalmol Soc* 5:122-137, 1953.
22. Amsler M. Schiff-Wertheimer S: Le décollement de la rétina, in Bailliart P, et al (eds): *Traité de'ophthalmologie.* Paris, Masson et Cie, 1939, Vol 5, pp 559-576.
23. Arruga H: Etiologia y patogenia del desprendimiento de la retina. *Acta XIV Concil Ophthalmol Hispania* 2:1-191, 1933.
24. Shapland CD: Retinal detachment techniques. *Trans Ophthalmol Soc UK* 80:677-689, 1960.
25. Cambiaggi A: Myopia and retinal detachment: Statistical study of some of their relationships. *Am J Ophthalmol* 58:642-650, 1964.
26. Campbell CJ, Rittler MC: Cataract extraction in the retinal detachment-prone patient. *Am J Ophthalmol* 72:17-24, 1972.
27. Benson WE, Grand MG, Okun E: Aphakic retinal detachment: Management of the fellow eye. *Arch Ophthalmol* 93:245-249, 1975.
28. Brown EVL, Kronfeld PC: The refraction curve in the USA with special reference to changes in the first two decades. *XIII Conc Ophthalmol (Hollandia),* 1:87-95, 1929.
29. Guttman E: Klinisch-statistiche Beiträge zur Aetiologie der hochgradigen Kurzsichtigkeit. *Arch f Ophthalmol* 54:268-299, 1902.

30. Kronfeld PC, Devney C: Ein Beitrag zur Kenntnis der Refraktionskurve. *Arch f Ophthalmol* 126:487-501, 1931.
31. Dunnington JH, Macnie JP: Detachment of the retina: operative results in 164 cases. *Arch Ophthalmol* 18:532-539, 1937.
32. Binkhorst PG: Statistische Betrachtungen über Natzhautablösung. *Ophthalmologica* 99:367-378, 1940.
33. Thiel, HL: Zur Aetiologie and Therapie der Amotio retinae. *Ber Dtsch Opthalmol Ges* 62:206-209, 1959.
34. Davis, MD: Natural history of retinal breaks without detachment. *Arch Ophthalmol* 92:183-194, 1974.
35. Davis MD, Segal PP, MacCormick A: The natural course followed by the fellow eye in patients with rhegmatogenous retinal detachment in Pruett RC, Regan CJD, (eds): *Retina Congress.* New York, Appleton-Century-Crofts, 1974, pp 643-660.
36. Lincoff H: Full-thickness scleral buckling with silicone sponge implant, in McPherson A (ed): *New and Controversial Aspects of Retinal Detachment.* New York, Harper and Row, pp 293-296, 1968.